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Please find below and/or attached an Office communication concerning this application or proceeding.

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GROUP 2800

BEFORE THE BOARD OF PATENT APPEALS AND INTERFERENCES

Application Number: 09/778,045
Filing Date: February 07, 2001
Appellant(s): KURAHASHI ET AL.

Joseph H. Rhoa
For Appellant

EXAMINER'S ANSWER

This is in response to the appeal brief filed 25 September 2006, 22 May 2006, 12 September 2005, and 2 May 2005. The Answer set forth below is identical to the

Response to Order of 5/24/2007

The accompanying Examiner's Answer corrects the statement of claims rejected, to include claims 21, 22, 25 and 26. This corresponds to the Final Rejection of 9/8/2004.

Appellant's time for response to this Answer would be as for an original Examiner's Answer.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to S. Crane, whose telephone number is (571) 272-1652.

The SPE for Art Unit 2811 is Lynne Gurley, who can be reached at 571 272-1670. The fax phone number for the organization where this application or proceeding is assigned is (571) 273-8300.

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Sara W. Crane
Sara W. Crane
Primary Examiner
Art Unit 2811

Answer of 8 August 2006, except that the headings have been changed to correspond to newly-required headings.

(1) Real Party in Interest

A statement identifying the real party in interest is contained in the brief.

(2) Related Appeals and Interferences

A statement identifying the related appeals and interferences which will directly affect or be directly affected by or have a bearing on the decision in the pending appeal is contained in the brief.

(3) Status of Claims

The statement of the status of the claims contained in the brief is correct.

(4) Status of Amendments After Final

The appellant's statement of the status of amendments after final rejection contained in the brief is correct.

(5) Summary of Claimed Subject Matter

The summary of claimed subject matter contained in the brief is correct.

(6) Grounds of Rejection to be Reviewed on Appeal

The appellant's statement of the grounds of rejection to be reviewed on appeal in the brief is correct.

(7) Claims Appealed

The copy of the appealed claims contained in the Appendix to the brief is correct.

(8) Evidence Relied Upon

5,779,924	Krames et al.	07-1998
6,350,997	Saeki	02-2002
5,426,657	Vakhshoori	06-1995

(9) Grounds of Rejection

The following ground(s) of rejection are applicable to the appealed claims:

Claim1-8 and 15-22 and 25-26 are rejected under 35 U.S.C. 103(a) as being unpatentable over Krames et al. in view of Saeki and Vakshoori.

As a preliminary matter, there are two claim terms that must be construed:

The first claim term is "roughened," as in claim 1, line 8. The specification, top of page 4, refers to a roughened surface as illustrated in figure 1B, which shows a randomized texturing. However, the figure embodiments of the specification all show an ordered or patterned texturing as the "roughened" surface. For example, the specification at page 18, line 22, teaches a 5 micron-pitch grating pattern, which at page 19, line 8, is referenced as "surface-roughened." Also, lines 10-17 make it clear that the grating pattern is considered "roughened," by contrast with an "unroughened" surface having no grating pattern.

So, examiner interprets the claim term "roughened surface" as encompassing both randomized texturing and ordered or patterned texturing, because Appellant's specification uses the terminology in this sense.

The second claim term to be construed is "diffused." This term does not appear to be used at all in the specification to refer light output from the device, and no definition has been provided. Dictionary definitions all seem to embody the notion of

something that is "spread out," so that light that is "diffused" would be light that is spread out, having an angular distribution in emission direction, rather than light that is emitted at a single angle. In other words, light emitted from a device is "diffused" if there is a cone describing its angular distribution, rather than a single line describing light emitted in a single direction or at a single angle. Examiner does not understand the term to require light to be spread out into all angles, or all available angles at a surface, or that there is no angular dependence whatever to the light distribution. The term is not understood to describe a uniform emission pattern, but merely an emission pattern that is spread out somehow. This seems to be the common usage of the term "diffuse" in the art ("diffuse" as opposed to "specular" or mirror-like, for example), and also seems to be consistent the properties of the emitted light as discussed in the specification, where figure 5 for example shows 650 nm light spread out into an angular distribution of 60 degrees.

Claim 1

Consider first the references of Krames et al. and Saeki. Krames et al. can be relied upon for the teaching of every limitation of the light emitting device in the claim except the DBR between the substrate and the light emitting layer, and the specific substrate material GaAs. Saeki teaches such a DBR, and provides reasons for its use in a light emitting device. Saeki also teaches GaAs substrate.

See for example Krames figure 7c, which shows an LED having active layer 2 and substrate 3, with a semiconductor layer 1 overlying the active layer 2. (Layers are

described in the paragraph spanning columns 6 and 7.) The top surface of the device has a roughened surface 7 which is not covered by other semiconductor layers. As noted above, "roughened" is understood to encompass the ordered texturing as taught by Krames et al., because this seems to be what Appellant's specification is teaching as well. The texturing of the top surface to increase the angular bandwidth of emitted light at the surface is taught throughout this reference, and is one of the goals of the Krames invention. See, for example, the last 5 lines of the Krames abstract, which teaches to increase the angular bandwidth of light, and to increase the escape cone at an interface. Also, column 5, lines 55-58, teaches that the ordered texturing of the interface can be designed to transmit light more efficiently at the larger oblique angles at the expense of smaller ones, if desired. The rest of this paragraph notes the trade-off between diffraction efficiency and angular bandwidth, and the states specifically that it may be desirable to tune the grating for maximum extraction efficiency at large oblique angles. So the Krames light output is not only "diffuse" (spread out into a distribution of angles), but the reference also notes that an increase in spread may be desirable, and the reference provides specific teachings of how to design the top layer of the device to achieve this desired goal.

The Krames teaching is not limited to any particular type of LED. The teaching applies to any device that has light output at its top layer, and the structure of figures 7, for example, requires only an active or light-emitting layer between other semiconductor layers, and on a substrate. Saeki is relied upon for its teaching of a lower optical reflection layer, included in an LED below the active or light-emitting layer. See figure

8B, which shows optical reflection layer 24, and active layer 26 (described in the paragraph spanning columns 8 and 9). The layer may be a Bragg reflector (column 9, lines 3-4). The optical reflection layer is included for the usual reason, i.e., to reflect the downward emitted light out of the top of the device. Without such a reflector, the downward emitted light would be largely wasted, and with the lower reflector, the downward emitted light can pass out of the top of the device and contribute to the desired light output. The device of Saeki figure 8B has no top DBR reflecting layer. 13 and 15 are clad layers, 21 is AlGaAs, and 22 is a contact layer (column 8, lines 48-54).

It would have been obvious to include a lower optical reflection layer, such as layer 24 in the Saeki device, below the light emitting layer of the Krames device, in order to re-direct the downward emitted light upward, so it won't be wasted.

A GaAs substrate would have been obvious in view of the Saeki teaching of such at column 5, line 13, in order to allow for the epitaxial formation of GaAs-based upper layers, in order to obtain the wavelength output of such layers. See Saeki column 5, lines 35 et seq, which describes the desired epitaxial growth on a GaAs substrate. The Vakhshoori reference also notes that GaAs is conventional for a substrate (column 2, last line). Figure 2 of Krames et al. also shows a GaAs substrate as prior art.

In addition, if "roughened surface" is understood to mean some sort of random texturing, this is taught as prior art in Krames et al. (column 2, lines 20-44), and such texturing would have been obvious for the reasons notes there (to increase the overall probability that light will enter the escape cone).

So, in summary, figure 7c of Krames et al, and its associated discussion, teaches a light emitting device having a "roughened surface" which causes light output from the device to be diffused upon leaving the top surface of the device. No DBR reflectors are taught. Saeki figure 8B teaches to include a lower reflector, which may be a DBR. It would have been obvious to include such a reflector in the Krames device to increase the light output from the top surface. Alternatively, it would have been obvious to texture the top surface of the device of Saeki figure 8B as taught by Krames et al., in order to increase the escape cone of the emitted light, for example, as taught by the Krames abstract.

Basically, claim 1 is drawn to an LED having a combination of a roughened or textured top surface, and a lower DBR reflector. In previous Office actions, one of the points raised by the examiner was the following: Krames et al. teaches not only a simple LED device having no reflectors (as in figures 1-12), but this reference also teaches a resonant cavity LED having two reflectors, top and bottom (figure 13). The examiner then concluded that it would have been obvious to leave out the top reflector, if its function were not desired. One might desire to make a device such as that of Saeki figure 8B, for example, which has no top reflector. Or, one might include a top reflector that is not a DBR, since the claims do not say that there is no top reflector at all, and since each known type of reflector has its own known advantages. Vakhshoori teaches at column 3, lines 1-22, multi-layer reflectors that are not described as DBRs, which function as mirrors. Of course, Appellant has not included any definition of DBR,

but Saeki column 9, lines 3-4, says that a Bragg reflector has two kinds of semiconductor layers having different refractive index, and the Vakhshoori mirrors have more than two kinds of layers.

Unfortunately, this approach seems to have obscured the Krames teaching, which applies primarily to LEDs without resonant cavities. The reasoning for the rejection really has nothing to do with resonant cavities, or lack of resonant cavities. Of course, figure 13 of Krames shows nicely the angular distribution or lobes in the emission profile ("diffused" emission), but increase in the angular distribution of the escape cone caused by the surface texturing is discussed at length throughout the reference, as noted above, and does not depend on whether the device does or does not include a resonant cavity. The resonant cavity embodiment has caused a lot of confusion, and probably should not have been mentioned in the first place.

Claims 2-8

With respect to claim 2, it would have been obvious to form the upper layers of the Krames light emitting device of GaP, because this is the material actually discussed in that reference (column 3, line 60, for example). With respect to claim 3, an upper layer 22 of the Saeki device is GaAs (column 8, line 53), which is $Al_xGa_{1-x}As$, with $x=0$. It would have been obvious to roughen the top layer for the reasons noted by Krames et al. With respect to claim 4, a transparent layer would have been obvious because otherwise the light could not get out of the device. With respect to claim 5, x is either between 0 and 1, or between 0.5 and 0.8. The first range encompasses GaAs, as

noted above, and the second range encompasses a layer having equal amounts of Al and Ga, such as layer 109 of Saeki figure 11 (GaAlAs). Use of a layer such as this current diffusion layer 109 instead of a transparent upper electrode is motivated by good current-voltage characteristics, noted at Saeki column 2, lines 32-46. With respect to claim 6, Saeki figure 10 shows clad layer 105 of InGaAlP (column 1, lines 42-43), which will also function to diffuse current from electrode 107. With respect to claim 7, Krames et al. contemplates an upper layer of GaP, because in figure 2 demonstrates an interface between GaP and the surrounding epoxy packaging material. With respect to claim 8, as noted above, Saeki teaches to form GaP devices on a GaAs substrate (column 1, lines 5-8, lines 23-30, and particularly lines 32-34). GaP has a lattice constant of 5.450, which is 3.6% different from that of GaAs (5.653).

Claims 15-22

As noted above in the discussion of claim 1, the roughened top surface for causing light output to be diffused is taught by Krames et al., in the abstract and at column 5, lines 55-63, for example. The inclusion of a DBR as a lower mirror is taught by Saeki, for directing light emitted downward into the desired upward direction. It would have been obvious to combine both features in a light emitting device, to achieve both goals. Each of claims 16-18 and 20-22 recites limitations which parallel those discussed above, and would have been obvious as noted above. Claim 19 includes an additional etch stop layer, which could be read on layer 21 of Saeki figure 8B, where 22

is the top layer and clad 15 would also serve to diffuse current. (Layer 22 would possess an etch stop function for some etch.)

Claims 25-26

Appellant's specification does not use the word "mirror" or "mirror/reflector" as recited in these claims, so once again some claim construction is necessary. Because some reflection of light will occur at any interface (between layers of different materials or different refractive index), the claims cannot mean that no reflection at all occurs between the light emitting layer and the top surface, because Appellant's device will have reflections occurring at layer interfaces. So these claims are understood to mean that none of the layers in the device between the active layer and the top surface have been included specifically for the purpose of mirroring or reflecting light. The devices of Krames figure 7c and Saeki figure 8b both meet this criterion.

(10) Response to Argument

Appellant notes that none of the references anticipates the claims. Examiner agrees. The rejection is based on obviousness. Appellant argues that no reason for combining the reference teachings is provided. Examiner disagrees. Krames teaches at length the desirability of surface texturing to enhance the angular distribution of light output. Saeki teaches the use of a reflecting layer beneath a light emitting layer to redirect light upward which would otherwise not contribute to the usefulness of the device. It is obvious to do both to obtain both goals.

Appellant notes that the Krames reference has embodiments drawn to resonance cavity devices, while Appellant's claims do not say anything about resonant cavities. As noted above, the Krames teachings apply to all devices that emit light through a top surface, and this reference includes embodiments drawn to both types of devices, including resonant cavities and not including resonant cavities. In either case, the surface texturing is motivated by the desire to enhance light emission characteristics, where transmitting light more efficiently at larger oblique angles, by increasing the escape cone at the interface, is specifically taught as desired. The examiner believes that the presence or absence of a cavity is really not relevant.

Appellant notes that the device of Saeki as taught has reduced operation voltage and increased optical output, so no improvement in light emission characteristics would be desired. Examiner disagrees. Designers always want to improve their devices, no matter how good they already are. That's exactly what this business is all about.

Appellant argues that the device of Krames does not have "scattered or diffused" light leaving the top surface of the device. The claims don't say anything at all about scattering, so the only thing that matters is what is meant by "diffused." This term was not used in the specification or claims as originally filed, and no definition has been provided, so its interpretation is left open. Examiner has interpreted the term to mean that there is some angular dependence to the light emission, consistent with the specification and the common usage of the term. Virtually all LEDs have an angular dependence to their emission. Think about it. The little red lights that glow on the TV or the humidifier can be seen from all over the room. A traffic light that could not be seen

except at one and only one angle would not be very useful. Even lasers, which can be designed with very sharp emission profiles, have some angular dependence to the emission, albeit small. The salient point in the teaching of Appellant's specification, and in the teaching of the Krames reference, is not merely the existence of an angular of dependency, or diffusivity, to the light output, which appears to be all that is required by the claims. The point of both of these teachings is that the surface texturing can be designed to increase that angular dependency, broadening the cone into which light is output.

Appellant notes that the prior art does not teach the specific growth processes that are supposed to give rise to the lattice constant difference of 0.5% or more, as in for example claim 8. None of these claims say anything at all about growth processes. Lattice constant differences can arise from the use of different materials for the different device layers. Krames teaches a GaP light emitter on an unnamed substrate, and Saeki teaches to grow mixed crystals, such as GaP, on a GaAs substrate. Indeed, GaAs seems to be the most commonly used substrate material for any material that can be grown on it, obvious for its availability if for no other reason.

Appellant argues that the Krames emission lobes (showing an angular distribution) apply only to the light emitted from the active layer, and that somehow the angular distribution disappears when the light exits the device. Examiner disagrees. The designation is "emission profile" which would appear to mean a profile of an emission. Moreover, there is no reason why such an angular distribution would disappear. However, the specific interpretation of these particular lobes is really not

relevant, because the reference has so many other teachings of an escape cone, or an angular dependence to the emitted light, or a large angular bandwidth, and of the desirability of transmitting light more efficiently into the larger angles.

(11) Related Proceeding(s) Appendix

No decision rendered by a court or the Board is identified by the examiner in the Related Appeals and Interferences section of this examiner's answer.

For the above reasons, it is believed that the rejections should be sustained.

Respectfully submitted,

Sara W. Crane
Primary Examiner
Art Unit 2811

December 4, 2006

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